

INTERNATIONAL
ASSOCIATION FOR TESTING MATERIALS.

AMERICAN SECTION.

BULLETIN No. 10.

MAY, 1900.

PROPOSED STANDARD SPECIFICATIONS
FOR
OPEN-HEARTH BOILER PLATE AND
RIVET STEEL.

RECOMMENDED BY AMERICAN BRANCH OF COMMITTEE NO. 1, MAY 1, 1900.

There will be a discussion of these specifications at the Third Annual Meeting of the American Section, to be held in New York, on October 25-27, 1900, and you are requested to send in your views by letter, or to be present and take part in the oral discussion.

After the Annual Meeting, Committee No. 1 will consider the points raised, and make any modifications that may be found necessary; and, if so decided at the Annual Meeting, the specifications will be sent to all members of the American Section for approval by letter ballot.

If the other countries perform their work in the same general manner, the final work of the introduction of International Specifications will be reduced to a very simple matter, as there will only be a limited number of specifications to consider instead of hundreds as at the present time.

WM. R. WEBSTER,

Chairman of American Branch of Committee No. 1.

PROCESS OF MANUFACTURE.

1. Steel shall be made by the open-hearth process.

CHEMICAL PROPERTIES.

2. There shall be three classes of open-hearth boiler plate and rivet steel, namely: FLANGE OR BOILER STEEL, FIRE BOX STEEL and EXTRA SOFT STEEL, which shall conform to the following limits in chemical composition:

	Flange or boiler steel. Per cent.	Fire box steel. Per cent.	Extra soft steel. Per cent.
Phosphorus shall not exceed...	0.06	0.04	0.04
Sulphur shall not exceed.....	0.05	0.04	0.04
Manganese.....	0.30 to 0.60	0.30 to 0.50	0.30 to 0.50

3. Steel for boiler rivets shall be of the EXTRA SOFT class as specified in paragraphs Nos. 2 and 4.

PHYSICAL PROPERTIES.

4. The three classes of open-hearth boiler plate and rivet steel, namely: FLANGE OR BOILER STEEL, FIRE BOX STEEL and EXTRA SOFT STEEL, shall conform to the following physical qualities:

Tensile Tests.	Flange or boiler steel.	Fire box steel.	Extra soft steel.
Tensile strength, pounds per square inch.....	55,000 to 65,000	52,000 to 62,000	45,000 to 55,000
Yield point in pounds per square inch shall not be less than.....	33,000	32,000	30,000
Elongation, per cent. in eight inches shall not be less than	25	26	28

5. For material less than five-sixteenths inch ($5/16''$), and more than three-fourths inch ($3/4''$) in thickness, the following modifications shall be made in the requirements for elongation:

Modifications
in elongation
for thin and
thick material.

- (a). For each increase of one-eighth inch ($1/8''$), in thickness above three-fourths inch ($3/4''$), a deduction of one per cent. (1%) shall be made from the specified elongation.



2. There shall be three classes of open-hearth boiler plate and rivet steel ; namely: FLANGE OR BOILER STEEL, FIRE BOX STEEL and EXTRA SOFT STEEL, which shall conform to the following limits in chemical composition :

	Flange or Boiler steel. Per cent.	Fire box steel. Per cent.	Extra soft steel. Per cent.
Phosphorus shall not exceed...	{ Acid 0.06 Basic 0.04	Acid 0.04 Basic 0.03	0.04
Sulphur shall not exceed	0.05	0.04	0.04
Manganese	0.30 to 0.60	0.30 to 0.50	0.30 to 0.50

4. The three classes of open-hearth boiler plate and rivet steel, namely : FLANGE OR BOILER STEEL, FIRE BOX STEEL and EXTRA SOFT STEEL, shall conform to the following physical qualities :

Tensile Tests.	Flange or boiler steel.	Fire box steel.	Extra soft steel.
Tensile strength, pounds per square inch	55,000 to 65,000	52,000 to 62,000	45,000 to 55,000
Yield point, in pounds per square inch shall not be less than.....	1/2 T. S.	1/2 T. S.	1/2 T. S.
Elongation, per cent. in eight inches shall not be less than.....	25	26	28

(b). For each decrease of one-sixteenth inch ($1/16''$) in thickness below five-sixteenths inch ($5/16''$) a deduction of two and one-half per cent. ($2\frac{1}{2}\%$) shall be made from the specified elongation.

6. The three classes of open-hearth boiler plate and rivet steel shall conform to the following bending tests; and for this purpose the test specimen shall be one and one-half inches ($1\frac{1}{2}''$) wide if possible, and for all material three-fourths inch ($3/4''$) or less in thickness the test specimen shall be of the same thickness as that of the finished material from which it is cut; but for material more than three-fourths inch ($3/4''$) thick, the bending test specimen may be one-half inch ($1/2''$) thick:

**Bending
Tests.**

Rivet rounds shall be tested of full size as rolled.

(c). Test specimens cut from the rolled material as specified above, shall be subjected to a cold bending test, and also to a quenched bending test. The cold bending test shall be made on the material in the condition in which it is to be used, and prior to the quenched bending test, the specimen shall be heated to a light cherry-red as seen in the dark and quenched in water, the temperature of which is between 80° and 90° Fahrenheit.

(d). Flange or boiler steel, fire box steel and rivet steel, both before and after quenching, shall bend cold one hundred and eighty degrees (180°) flat on itself without fracture on the outside of the bent portion.

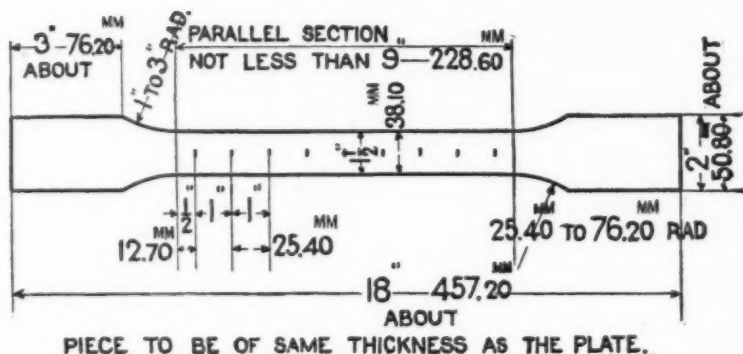
7. For fire box steel a sample taken from a broken tensile test specimen, shall not show any single seam or cavity more than one-fourth inch ($1/4''$) long in either of the three fractures obtained on the test for homogeneity as described below in paragraph 12.

**Homogeneity
Tests.**

TEST PIECES AND METHODS OF TESTING.

8. The standard test specimen of eight inch ($8''$) gauged length, shall be used to determine the physical properties specified in paragraphs Nos. 4 and 5. The standard shape of the test specimen for sheared plates shall be as shown by the following sketch:

**Test Specimen
for Tensile
Test.**



For other material the test specimen may be the same as for sheared plates, or it may be planed or turned parallel throughout its entire length and in all cases where possible, two opposite sides of the test specimens shall be the rolled surfaces. Rivet rounds and small rolled bars shall be tested of full size as rolled.

9. One tensile test specimen will be furnished from each plate as it is rolled, and two tensile test specimens will be furnished from each melt of rivet rounds. In case any one of these develops flaws or breaks outside of the middle third of its gauged length, it may be discarded and another test specimen substituted therefor.

10. For material three-fourths inch ($3/4"$) or less in thickness, the bending test specimen shall have the natural rolled surfaces on two opposite sides. The bending test specimens cut from plates shall be one and one-half inches ($1\ 1/2"$) wide and for material more than three-fourths inch ($3/4"$) thick the bending test specimens may be one-half inch ($1/2"$) thick. The bending test specimens for rivet rounds shall be of full size as rolled. The bending test may be made by pressure or by blows.

11. One cold bending specimen and one quenched bending specimen will be furnished from each plate as it is rolled. Two cold bending specimens and two quenched bending specimens will be furnished from each melt of rivet rounds. The homogeneity test for fire box steel shall be made on one of the broken tensile test specimens.



10. For material three-fourths inch ($3/4''$) or less in thickness, the bending test specimen shall have the natural rolled surface on two opposite sides. The bending test specimens cut from plates shall be one and one-half inches ($1\ 1/2''$) wide and for material more than three-fourths inch ($3/4''$) thick the bending test specimens may be one-half inch ($1/2''$) thick. The sheared edges of bending test specimens may be milled or planed. The bending test specimens for rivet rounds shall be of full size as rolled. The bending test may be made by pressure or by blows.

COMPILED FOR COMMITTEE NO. 1—AMERICAN SECTION, INTERNATIONAL A

Name and date.	Grade.	Chemistry.							Elastic limit lbs. per sq. in.	Tensile		Elongation, per cent. in 8 in.	Reduction of area, per cent.
		Car. Min.	Car. Max.	Phos. Max.	Mn. Max.	Sil Max.	Sul. Max.	Copper Max.		strength lbs. per sq. in.			
										Min.	Max.		
Association, American Steel Mfgs., 1896	flange or boiler firebox.			.06 .04			.04 .04		1½ 1½	52,000 52,000	62,000 62,000	25 28	
Baltimore and Ohio R. R., No. 11a, Dec. 1, 1897	boiler firebox.			.05 .035	.45	.03	.04 .035	.05		55,000 53,000	65,000 63,000	25 26	
Brooks Locomotive Works	boiler shell firebox.	.15	.25	.03	.45	.035	.03			52,000 50,000	60,000 58,000	25 26	50 56
Burnham, Williams & Co., Jan. 1, 1895	flange firebox.	.15	.25	.05 .03	.45 .45	.03 .03	.05 .035			55,000 55,000	65,000 65,000	20	
Canadian Pacific Ry.	boiler firebox.			.025	.40	.025	.025			50,000 50,000	65,000 58,000	{ 25 in 2 in. 28 in 8 in. ¾ in. t. over 25 in 8 in. under ¾ in. 20 22 20 in ¼ in. plt. 22	
C. C. C. & St. L. Ry., No. 7, May, 1894	boiler firebox.	.15	.25	.035	.45	.03	.035			55,000	65,000		
Chicago, Burlington & Quincy, No. 1, Sept., 1895	boiler shell fire box.	.15	.25	.035 .035	.45 .45	.03 .03	.035 .035			55,000 55,000	65,000 65,000		
Cooke Locomotive Works	boiler and flange firebox	Same as American Steel Mfgs.											
Great Northern Ry., No. 16, Oct. 1, 1895		.13	.20	.03	.40	.02	.03	.03		55,000 52,000	65,000 60,000	{ 23 long'l. 20 trans. 25 l. or t. 25	
Hartford Steam Boiler In- spection & Insurance Co.				.04			.03		32,000	55,000	62,000	{ 25 in ¾ in. t. over. 22.5 over ¾ in. in. to ¾ in. 20 in ¾ in. or less. 25 to 32.	56
Heine Safety Boiler Co.										54,000	62,000		
L. S. & M. S., Sept. 16 1897	boiler firebox.	.12	.20	.05	.30/40	.02	.03			48,000	55,000	24 25	50 55
Missouri Pacific Ry., No. 10, Sept. 22, 1897	boiler firebox.	.12	.20	.03	.30/40	.02	.02			48,000	55,000	20	
Norfolk and Western Ry., No. 4C, Jan. 1, 1895	shell firebox.	.15	.25	.035	.45	.03	.035			55,000	65,000	{ 22 in ½ in. t. over. 20 in ¼ in. t.	
Northern Pacific Ry., No. 13, Nov. 1, 1898	boiler shell firebox.	.12	.25	.035 .035	.45 .40	.03	.03 .02			57,000 55,000	65,000 65,000	24 26	
Penna. Railroad Co., No. 1B, Oct. 26, 1896	boiler shell firebox.	.15	.25	.05 .035	.45	.03	.045 .035	.05		55,000 55,000	65,000 65,000	1,400,000 ÷ ult. 1,450,000 ÷ ult.	
Pgh., Bessemer and Lake Erie	boiler firebox.	.15	.25 .25	.05 .03	.45 .45	.05 .03	.05 .035			52,000	62,000	25	
Pgh. Locomotive Works Jan. 2, 1894	flange & shell firebox.	.12	.20	.05 .035	.35/50	.045	.045 .035			52,000	62,000	{ 25 in ¾ in. t. over. 22.5 in ¾ in. t. 20 in ¼ in.	
Queen and Crescent Route, No. 1, July 30, 1894	boiler firebox.	.15	.25	.035	.45	.03	.045			50,000	58,000	25 22	
Richmond Loco. & Mch. Works	boiler firebox.	.15	.25	.05 .035	.45	.03	.05 .035			55,000	65,000	20	
Schenectady Loco. Works, No. 1B, Aug. 12, 1895	boiler firebox.	.15	.25	.05 .035	.45	.03	.035			55,000 55,000	65,000 65,000	{ 23 over ¼ in. thick. 22 in ¼ in. t.	
Southern Pacific Co., No- 27, Sept. 25, 1897	boiler shell firebox.			.035	.45		.03			50,000	62,000	24 25 26	
Southern Ry. Co., Dec. 1, 1895	boiler firebox.			.05						55,000	65,000	{ 22 20 in ¼ in. t. 23 in ¾ in. t. 21 in ¼ in. t.	
Wabash Railroad	boiler firebox.	.12	.20	.05 .03	.30/40	.02	.03 .02			54,000 54,000	62,000 62,000	24 25	50 55
White Pass & Yukon Ry., 1899	boiler.								As specified on order.	60,000	70,000	20 in 10 in.	
U. S. Marine Law, Jan. 1898				.06			.04					{ 25 in 2 in. up to ¼ in. 25 in 4 in. over ¼ in. to ½ in. 25 in 6 in. over ½ in. to 1½ in.	50 in ¼ in. t. and under. 45 over ¼ in. to ½ in. 32.5 over ½ in. to 1½ in.
Mexican Central Ry., Oct. 2, 1899	boiler firebox.	Same as Penna. R. R. Co.											

area, per	Bends: H = Hot. C = Cold. Q = Quench.	Homogen- ity test.	Number of tensile tests.	Remarks.
.....	180° flat C., Q.	.....	Two per melt.	
.....	" " H., C., Q.	Yes.	One per slab.	Either long'l or trans. One long'l, one trans.
.....	" " C., Q.	Yes.	Two per slab.	
.....	" " C., Q.	.....	One per plate.	
.....		.....	One per slab.	
.....		"	
.....	180° flat, C., Q.	.....	"
.....	" " Q.	Yes.	"	
.....	" " H., C., Q.	Yes.	"	
.....	180° flat, C., Q.	.....	Two per slab.	One long'l, one trans. { Plates will not be rejected for high T. S. if elongation is 28% long'l and 25% trans. Plates will not be rejected for high T. S. if elongation is 30% long. and 28% trans.
.....	" " H., C., Q.	Yes.	One each plate	
.....	180° flat H., C. up to 1/4 in. t.	Yes.	Three per heat	
.....	180° D.=1 1/2 t. H., C. o. 1/4 in. t.	.....	One each plate	
.....	180° flat, H., C.	.....	.....
.....	180° flat, Q.	Yes.	four per slab.	
.....	" " C., Q.	Yes.	One per slab	
.....	" " H., C., Q.	Yes.	One per plate.	
.....	" " " "	Yes.	"	
.....		.....	"	Plates will not be rejected for high T. S. if elong. is 28% or over.
.....		Yes.	"	" " " " " " " " 30% "
.....		.....	One per slab.	
.....	180° flat, C., Q.	.....	"	Fire box plates 1/4 in. t. will be accepted with T. S. 60,000 lbs. El. 22%.
.....	" " "	"	
.....	" " C.	.....	"
.....	" " H., C., Q.	Yes.	"	Pits. will not be rejected for high t. s. if elon. is 27% or over } If not caused " 30% " } by cold rolling.
.....	" " " "	Yes.	"	
.....	" " " "	"	
.....	" " C., Q.	.....	"
.....		"	
.....		"	
.....		Yes.	"	
.....	180° flat, Q.	Yes.	Four per slab.	Compare with Mo. Pacific Ry.
.....	" " C.	Yes.	"	
.....		.....	One per plate.	
.....		.....	One per slab.	

1 under.
5 1/4 in.
to 1 1/4 in.

12. The homogeneity test for fire box steel is made as follows : A portion of the broken tensile test specimen is either nicked with a chisel or grooved on a machine, transversely about a sixteenth of an inch ($1/16''$) deep, in three places about two inches ($2''$) apart. The first groove should be made on one side, two inches ($2''$) from the square end of the specimen ; the second, two inches ($2''$) from it on the opposite side ; and the third, two inches ($2''$) from the last, and on the opposite side from it. The test specimen is then put in a vise, with the first groove about a quarter of an inch ($1/4''$) above the jaws, care being taken to hold it firmly. The projecting end of the test specimen is then broken off by means of a hammer, a number of light blows being used, and the bending being away from the groove. The specimen is broken at the other two grooves in the same way. The object of this treatment is to open and render visible to the eye any seams due to failure to weld up, or to foreign interposed matter, or cavities due to gas bubbles in the ingot. After rupture, one side of each fracture is examined, a pocket lens being used if necessary, and the length of the seams and cavities is determined.

Homogeneity
Tests for
Fire Box
Steel.

13. For the purposes of this specification, the yield point shall be determined by the careful observation of the drop of the beam or halt in the gauge of the testing machine.

Yield
Point

14. In order to determine if the material conforms to the chemical limitations prescribed in paragraph No. 2 herein, analysis shall be made of drillings taken from a small test ingot. An additional check analysis may be made from a tensile specimen of each melt used on an order, other than in locomotive fire-box steel. In the case of locomotive fire-box steel a check analysis may be made from the tensile specimen from each plate as rolled.

Sample for
Chemical
Analysis.

VARIATION IN WEIGHT.

15. The variation in cross section or weight of more than $2\frac{1}{2}$ per cent. from that specified will be sufficient cause for rejection, except in the case of sheared plates, which will be covered by the following permissible variations :

(e). Plates 12 1/2 pounds per square foot or heavier, when ordered to weight, shall not average more than 2 1/2 per cent. variation above, or 2 1/2 per cent. below the theoretical weight.

(f). Plates under 12 1/2 pounds per square foot, when ordered to weight, shall not average a greater variation than the following :

Up to 75 inches wide, 2 1/2 per cent. above or 2 1/2 per cent. below the theoretical weight.

75 inches and over, 5 per cent. above or 5 per cent. below the theoretical weight.

(g). For all plates ordered to gauge, there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table :

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES
WHEN ORDERED TO GAUGE.

The weight of 1 cubic inch of rolled steel is assumed to be 0.2833 pound.

Plates 1/4 inch and over in thickness.

Thickness of plate. Inch.	Width of plate.		
	Up to 75 inches. Per cent.	75 to 100 inches. Per cent.	Over 100 inches. Per cent.
1/4	10	14	18
5/16	8	12	16
3/8	7	10	13
7/16	6	8	10
1/2	5	7	9
9/16	4 1/2	6 1/2	8 1/2
5/8	4	6	8
Over 5/8	3 1/2	5	6 1/2

Plates under 1/4 inch in thickness.

Thickness of plate. Inch.	Width of plate.	
	Up to 50 inches. Per cent.	50 inches and above. Per cent.
1/8 up to 5/32	10	15
5/32 " 3/16	8 1/2	12 1/2
3/16 " 1/4	7	10

FINISH.

16. All finished material shall be free from injurious surface defects and laminations, and must have a workmanlike finish.



(e) Plates 12 1/2 pounds per square foot or heavier, up to 100 inches wide, when ordered to weight, shall not average more than 2 1/2 per cent. variation above or 2 1/2 per cent. below the theoretical weight. When 100 inches wide and over 5 per cent. above or 5 per cent. below the theoretical weight.

(f) Plates under 12 1/2 pounds per square foot, when ordered to weight, shall not average a greater variation than the following :

Up to 75 inches wide, 2 1/2 per cent. above or 2 1/2 per cent. below the theoretical weight. 75 inches wide up to 100 inches wide, 5 per cent. above or 3 per cent. below the theoretical weight. When 100 inches wide and over 10 per cent. above or 3 per cent. below the theoretical weight.

* * * * *

(g) For all plates ordered to gauge, there will be permitted an average excess of weight over that corresponding to the dimensions on the order equal in amount to that specified in the following table :

TABLE OF ALLOWANCES FOR OVERWEIGHT FOR RECTANGULAR PLATES
WHEN ORDERED TO GAUGE.

Plates will be considered up to gauge if measuring not over 1/100 inch less than the ordered gauge.

The weight of 1 cubic inch of rolled steel is assumed to be 0.2833 pound.

BRANDING.

17. Every finished piece of steel shall be stamped with the melt number, and each plate, and the coupon or test specimen cut from it, shall be stamped with a separate identifying mark or number. Rivet steel may be shipped in bundles securely wired together with the melt number on a metal tag attached.

INSPECTION.

18. The inspector representing the purchaser, shall have all reasonable facilities afforded to him by the manufacturer to satisfy him that the finished material is furnished in accordance with these specifications. All tests and inspections shall be made at the place of manufacture, prior to shipment.